

## CLAIMS

What is claimed is:

1. A coupler comprising:  
a dielectric substrate having first and second surfaces; and  
at least a first coupler section including:  
a first spiral including a first spiral portion on the first surface and a second spiral portion on the second surface; and  
a second spiral including a third spiral portion on the first surface and a fourth spiral portion on the second surface;  
the first and second spirals being mutually inductively coupled.
2. A coupler according to claim 1, in which the first spiral includes input and output terminals on the first surface, and the second spiral includes input and output terminals on the second surface.
3. A coupler according to claim 1, in which the spirals each have an intermediate portion and end portions, with the width of the spirals being different in the intermediate portion than in the end portions.
4. A coupler according to claim 3, in which the widths of the spirals are wider in the intermediate portions than in the end portions.

5. A coupler according to claim 1, in which the first spiral includes a fifth spiral portion on the first surface, the fifth spiral portion being separated from the first spiral portion by the second spiral portion.

6. A coupler according to claim 1, in which portions of the first and fourth spiral portions are in parallel and portions of the second and third spiral portions are in parallel.

7. A coupler according to claim 1, in which the dielectric substrate is less than 10 mils thick.

8. A coupler according to claim 7, in which the dielectric substrate is less than 6 mils thick.

9. A coupler according to claim 7, in which the first and second spirals are N quarter wavelengths of a design frequency long.

10. A coupler according to claim 9, in which the design frequency is between 100 MHz and 10 GHz.

11. A coupler according to claim 9, in which the design frequency is greater than 1 GHz.

12. A coupler according to claim 1, in which the first and second spirals are mounted on the first and second surfaces of the dielectric substrate.

13. A coupler according to claim 1, further comprising a first ground layer generally parallel to and spaced from at least a part of the first portion of the first spiral, and a first layer of air separating the part of the first portion of the first spiral from the first ground layer.

14. A coupler according to claim 13, further comprising a second ground layer generally parallel to and spaced from at least a part of the second portion of the second spiral, and a second layer of air separating the part of the second portion of the first spiral from the first ground layer.

15. A coupler according to claim 13, in which the first ground layer is separated from the part of the first portion of the first spiral by a first distance, the coupler further comprising a second coupler section including a first conductor mounted on the first surface of the dielectric substrate and connected to the first spiral and a second conductor mounted on the second surface of the dielectric substrate and connected to the second spiral, and the first ground layer is spaced from the second coupler section by a second distance less than the first distance.

16. A coupler according to claim 15, further comprising a second dielectric substrate extending between the second coupler section and the first ground layer.

17. A coupler according to claim 15, in which the first and second conductors of the second coupler section extend generally in parallel, and each of the first and second conductors in the second coupler section include an intermediate portion and end portions, with the end portions having a width that is less than the intermediate portion.

18. A coupler according to claim 17, in which the first and second conductors of the second coupler section each further include an extension extending from and transverse to the respective intermediate portion, the two extensions extending in opposite directions.

19. A coupler according to claim 1, further comprising an extension extending from and transverse to an intermediate portion of each of the first and second spirals, the extensions extending in mutually non-overlapping relationship.

20. A coupler according to claim 19, further comprising a first layer opposite the substrate, having a low dielectric constant disposed adjacent to at least a portion of the first and second spirals, and a thermally conductive second layer opposite the substrate and disposed adjacent to each extension.

21. A coupler according to claim 20, in which the first layer is air.
22. A coupler according to claim 1, in which the first and second spirals are substantially in opposing relationship relative to the dielectric substrate.
23. A coupler according to claim 1, further comprising a second coupler section including a first conductor mounted on the first surface of the dielectric substrate and connected to the first spiral and a second conductor mounted on the second surface of the dielectric substrate and connected to the second spiral.
24. A coupler according to claim 23, further comprising a second dielectric substrate extending between the second coupler section and the first ground layer.
25. A coupler according to claim 23, in which the first and second conductors of the second coupler section extend generally in parallel, and each of the first and second conductors include an intermediate portion and end portions, with the end portions each having a width that is less than the intermediate portion.
26. A coupler according to claim 25, in which the first and second conductors of the second coupler section each further include an extension extending from and transverse to the respective intermediate portion, the two extensions extending in different directions.

27. A spiral hybrid coupler comprising:  
a dielectric substrate having opposing first and second surfaces; and  
a first conductor having first and second ends and forming a first spiral between the first and second ends; and  
a second conductor having third and fourth ends and forming a second spiral between the third and fourth ends;  
the first and second conductors being disposed on opposite surfaces of the substrate, the first and second spirals including a first spiral portion on a respective one of the first and second surfaces and a second spiral portion on the respective other of the first and second surfaces.

28. A coupler according to claim 27, in which the first and second ends are on the first surface and the third and fourth ends are on the second surface.

29. A coupler according to claim 27, in which the first and second spirals include a third spiral portion on the respective one surface, the respective second spiral portion being electrically between the respective first and third spiral portions.

30. A coupler according to claim 29, in which the conductors have widths, and the widths of the first and second conductors in the second spiral portion are wider than the widths of the first and second conductors in the first and third spiral portions.

31. A coupler according to claim 29, in which the first and second conductors each include an extension extending from and transverse to the portion of the associated conductor forming the second spiral portion, the extensions extending in mutually non-overlapping relationship.

32. A coupler according to claim 27, in which the dielectric substrate is less than 10 mils thick.

33. A coupler according to claim 32, in which the dielectric substrate is less than 6 mils thick.

34. A coupler according to claim 32, in which the first and second spirals are N quarter wavelengths of a design frequency long.

35. A coupler according to claim 34, in which the design frequency is between 100 MHz and 10 GHz.

36. A coupler according to claim 35, in which the design frequency is greater than 1 GHz.

37. A coupler according to claim 27, further comprising a first ground layer generally parallel to and spaced from at least a part of the first portion of the first spiral, and a layer of air separating the part of the first portion of the first spiral from the first ground layer.

38. A coupler comprising:  
a dielectric substrate having opposing first and second surfaces; and  
a first conductor having first and second ends; and  
a second conductor having third and fourth ends;  
the first and second conductors forming a first coupled section including an intermediate portion and end portions, with the end portions having a width that is less than the intermediate portion.

39. A coupler according to claim 38, in which the first and second conductors of the second coupler section each further include an extension extending from and transverse to the respective intermediate portion, the two extensions extending in non-overlapping relationship.

40. A coupler according to claim 39, in which the two extensions extend in opposite directions.



41. A coupler according to claim 39, in which the two extensions include a narrow proximal portion, and a broad distal portion.

42. A coupler according to claim 39, in which the first and second conductors further include an uncoupled section adjacent to the coupled section, the first and second conductors extending in opposite directions in the uncoupled direction.

43. A coupler according to claim 42, in which the first and second conductors further form a second coupled section, the uncoupled section being positioned between the first and second coupled sections.